Drought Impacts on Microcystis

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Collaborators

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California Department of Water Resources

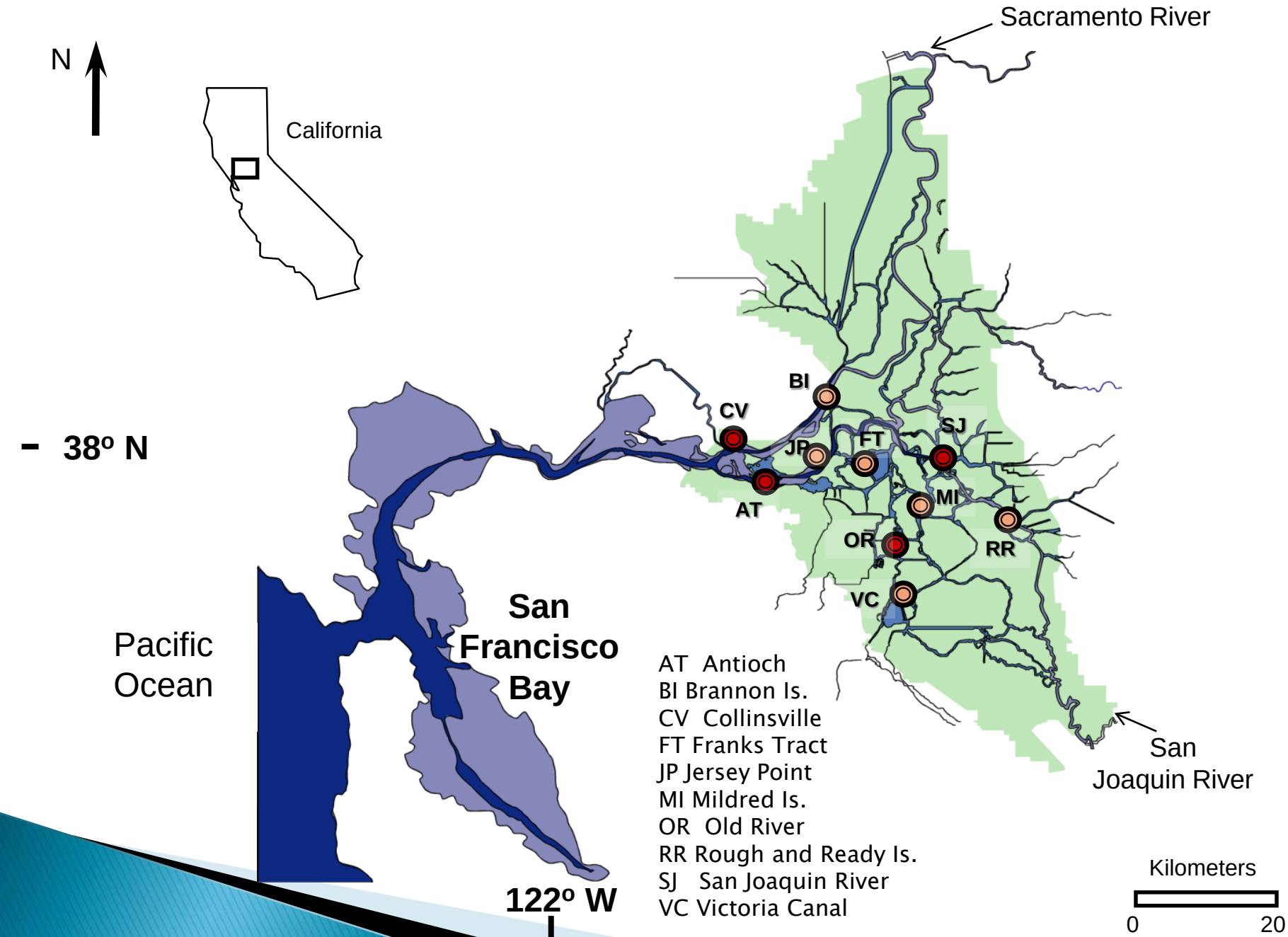
Background

- Colonial cyanobacterium (blue-green algae)
- Blooms began for Delta in 1999
- Occurs throughout the delta, highest in San Joaquin River
- Contains toxins that promote liver cancer
- Diameter 6 to 50,000 μm
- Bloom begins when water temperature >18°C
- Does not fix nitrogen, requires nitrogen source
- Bloom peaks in August and September, usually
- Vertically migrates to surface each day

What does *Microcystis* like?
DROUGHT

- ✓ Warm water temperature
- ✓ High light intensity
- ✓ Low flushing time
- ✓ Low turbulence – stratification
- ✓ High nutrient concentration, particularly ammonium

2014 Drought


N
California
Sacramento River
38º N
BI
CV
JP
FT
SJ
AT
MI
OR
RR
VC
Pacific Ocean
San Francisco Bay
AT Antioch
BI Brannon Is.
CV Collinsville
FT Franks Tract
JP Jersey Point
MI Mildred Is.
OR Old River
RR Rough and Ready Is.
SJ San Joaquin River
VC Victoria Canal
San Joaquin River
Kilometers
0
20
122º W

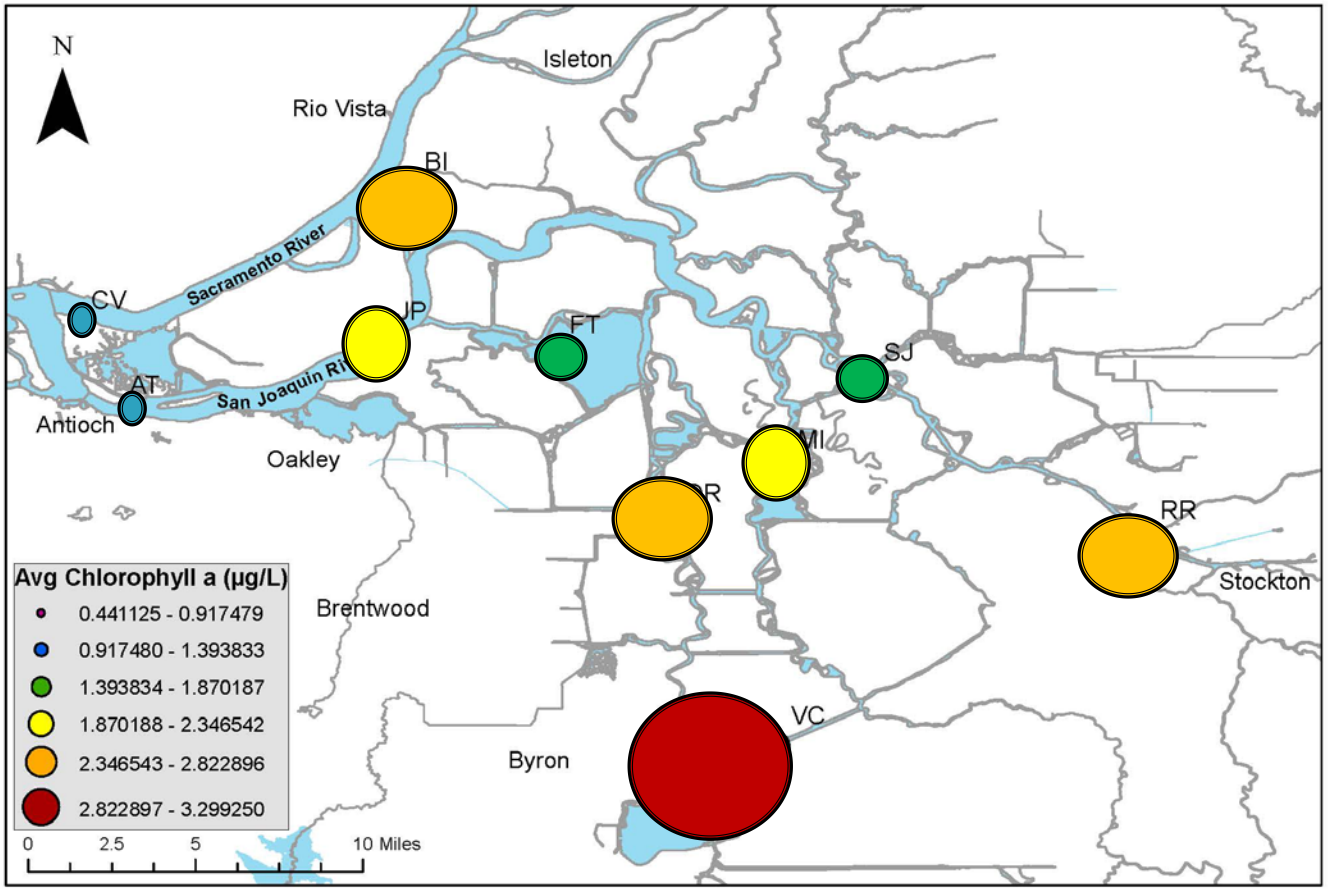
Methods

- Sampled every two weeks July through December
- Surface water samples for water quality analyses
- Surface physical factors with YSI sondes
- Surface net tows for *Microcystis* biomass

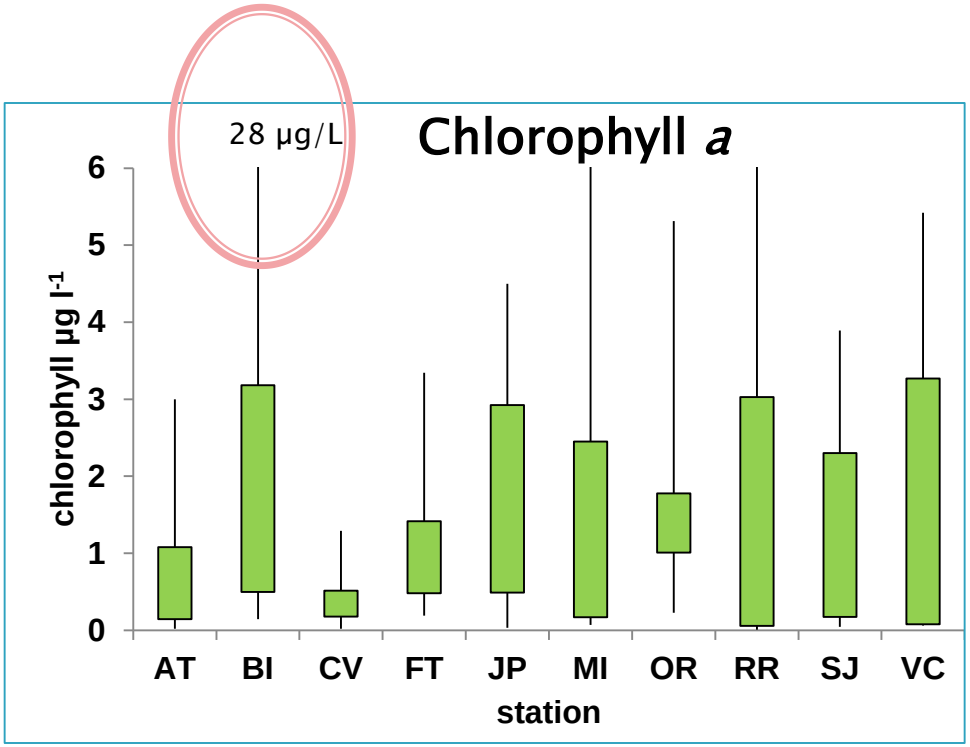
Results

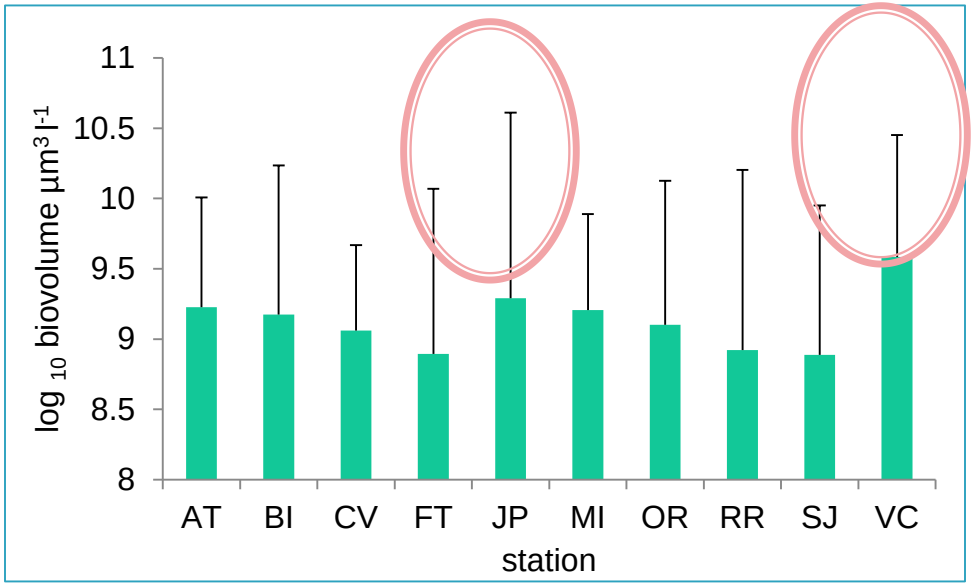
Widely distributed

August and September 2014

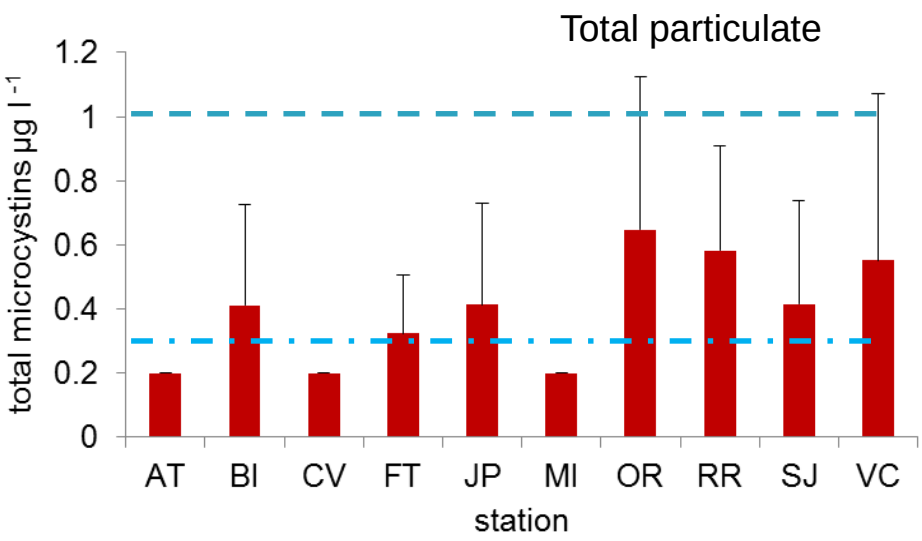


High biomass





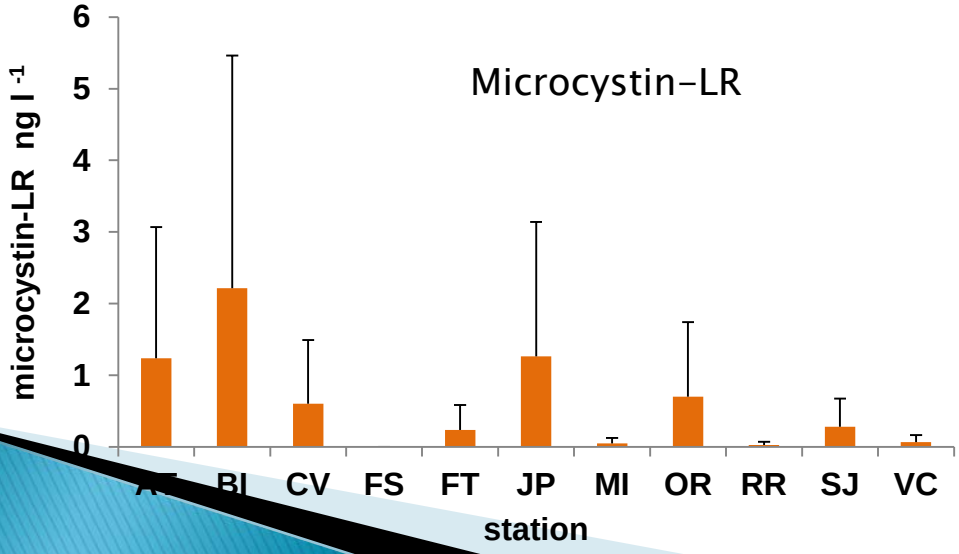
High toxin concentration



U.S. EPA (DW) **California (rec)**

1.6 µg/L adults 0.8 ug/L

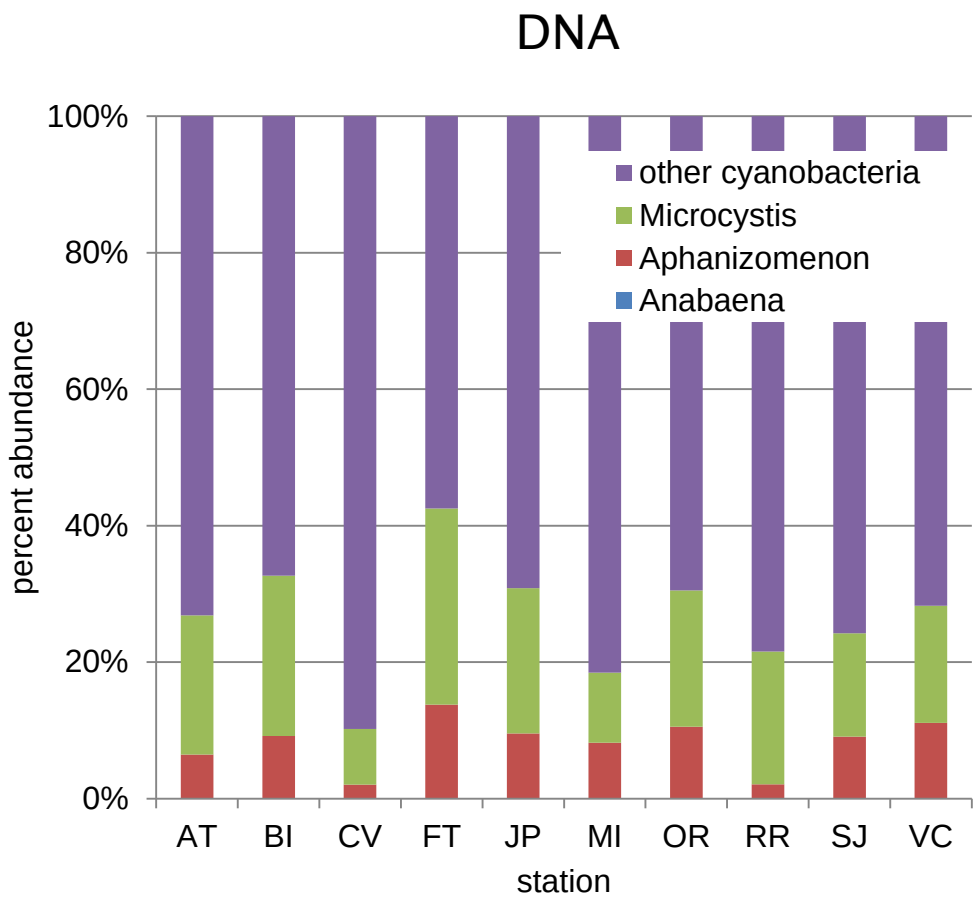
0.3 µg/L Children < 6 yr

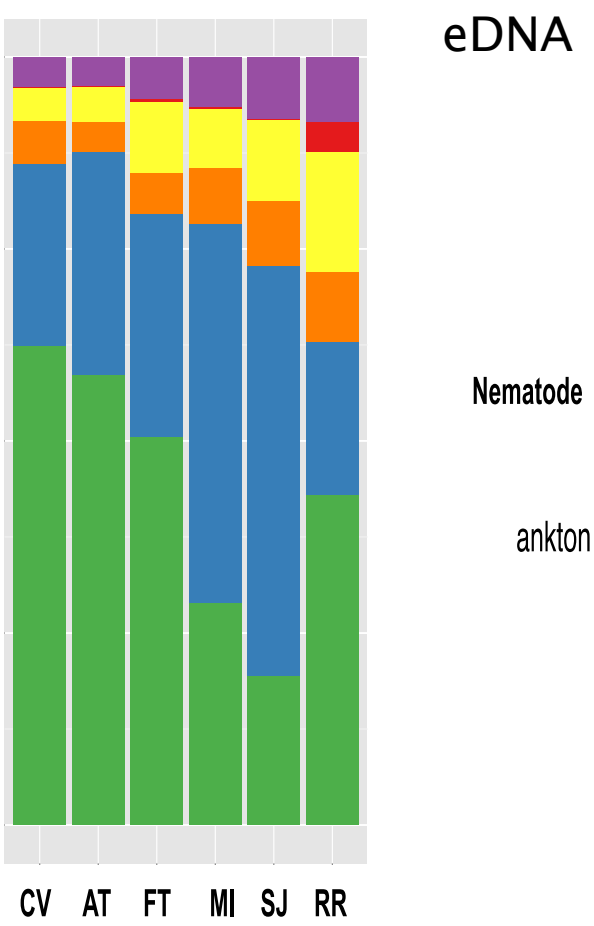


W.H.O.

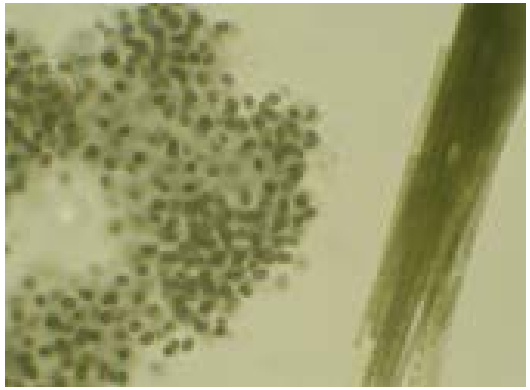
1 µg/L

High cyanobacteria diversity



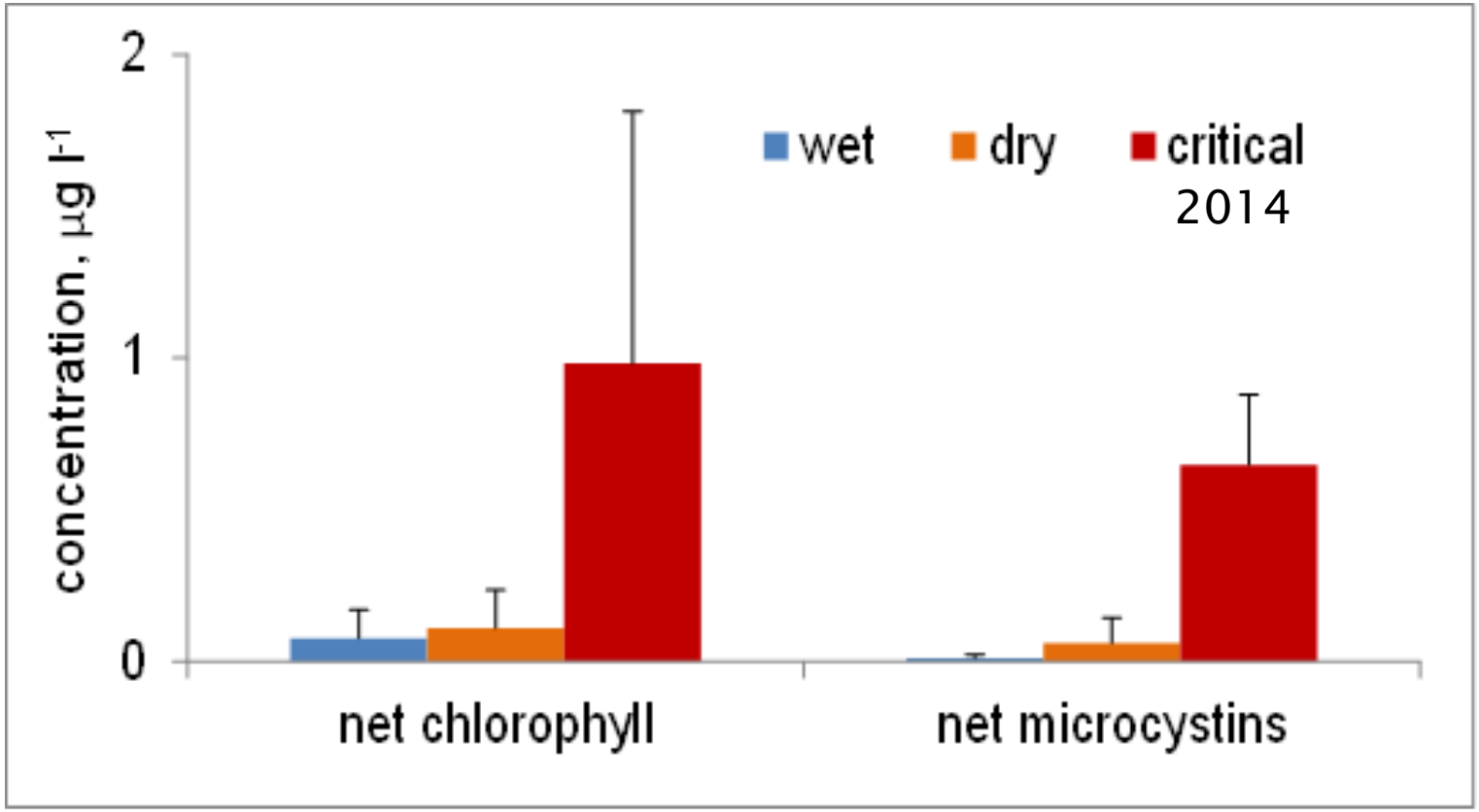


Kurobe et al. in prep



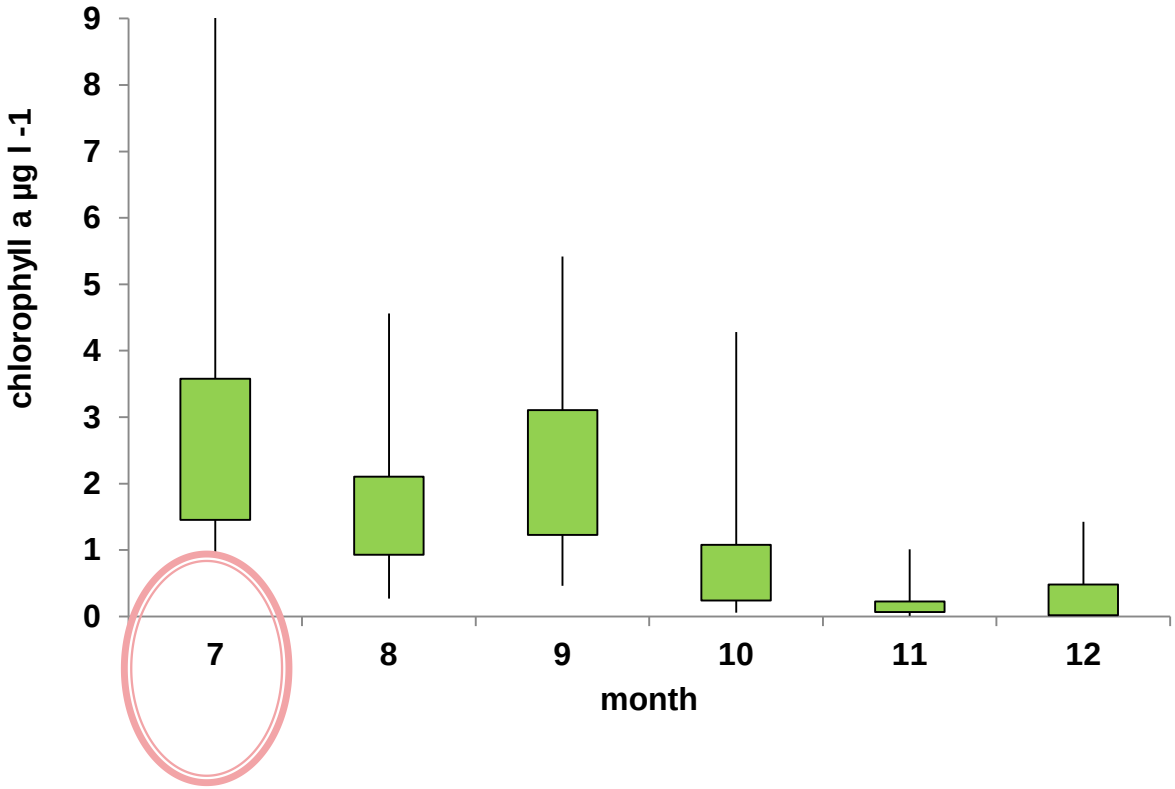
Historical comparisons

Largest bloom

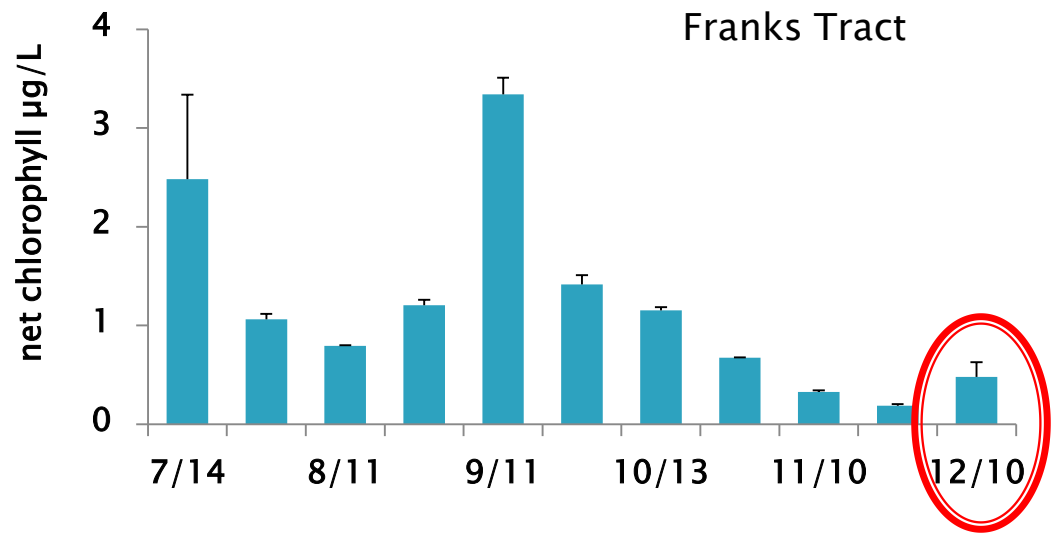


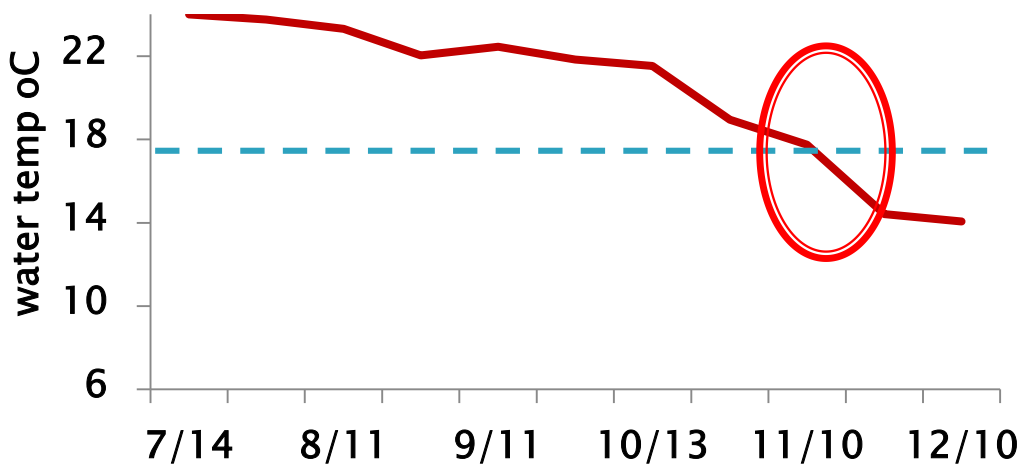
Wet: 2004-2005
Dry: 2007-2008

Earlier initiation and peak

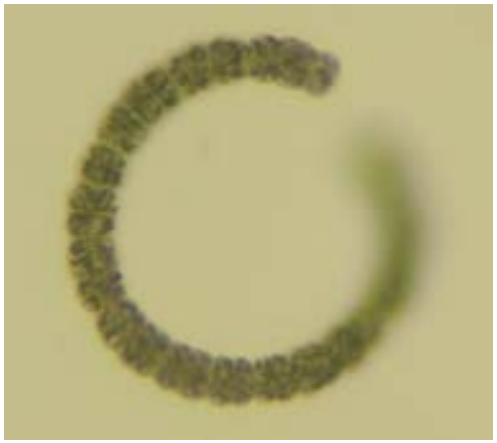


Longest duration





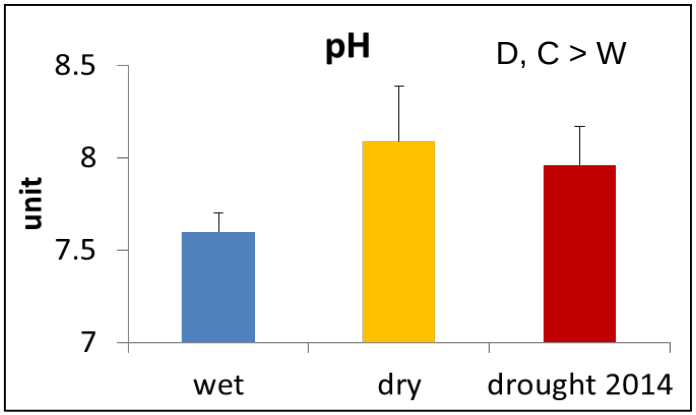
Environmental factors

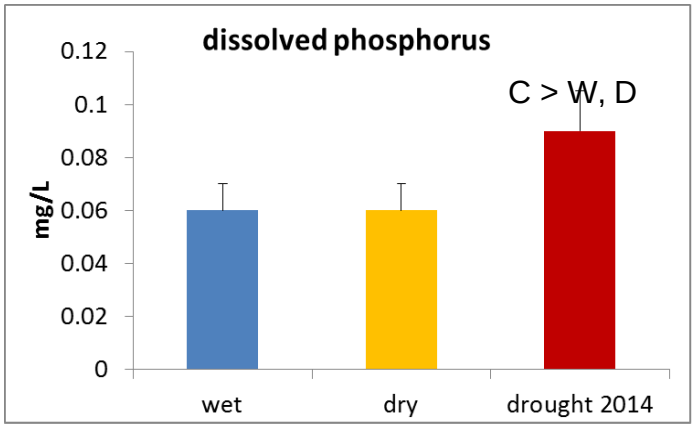


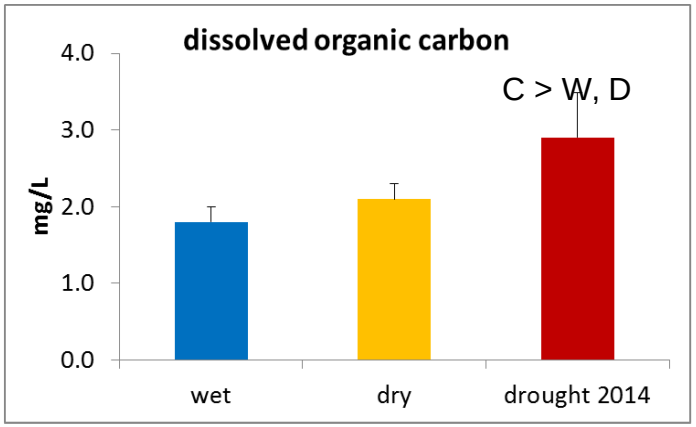
Physical and chemical

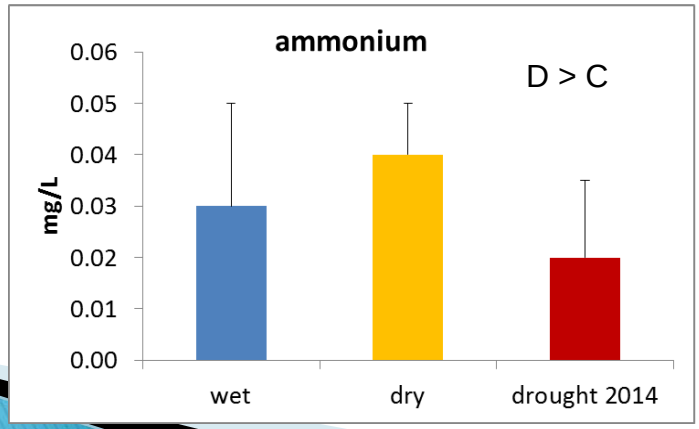
Not different

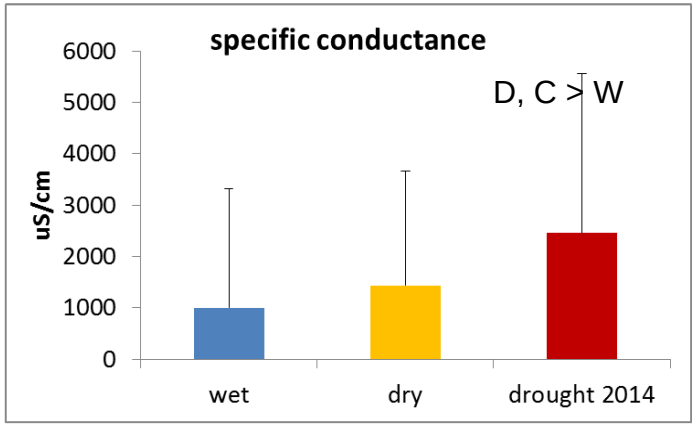
Water temperature
Turbidity nitrate silica



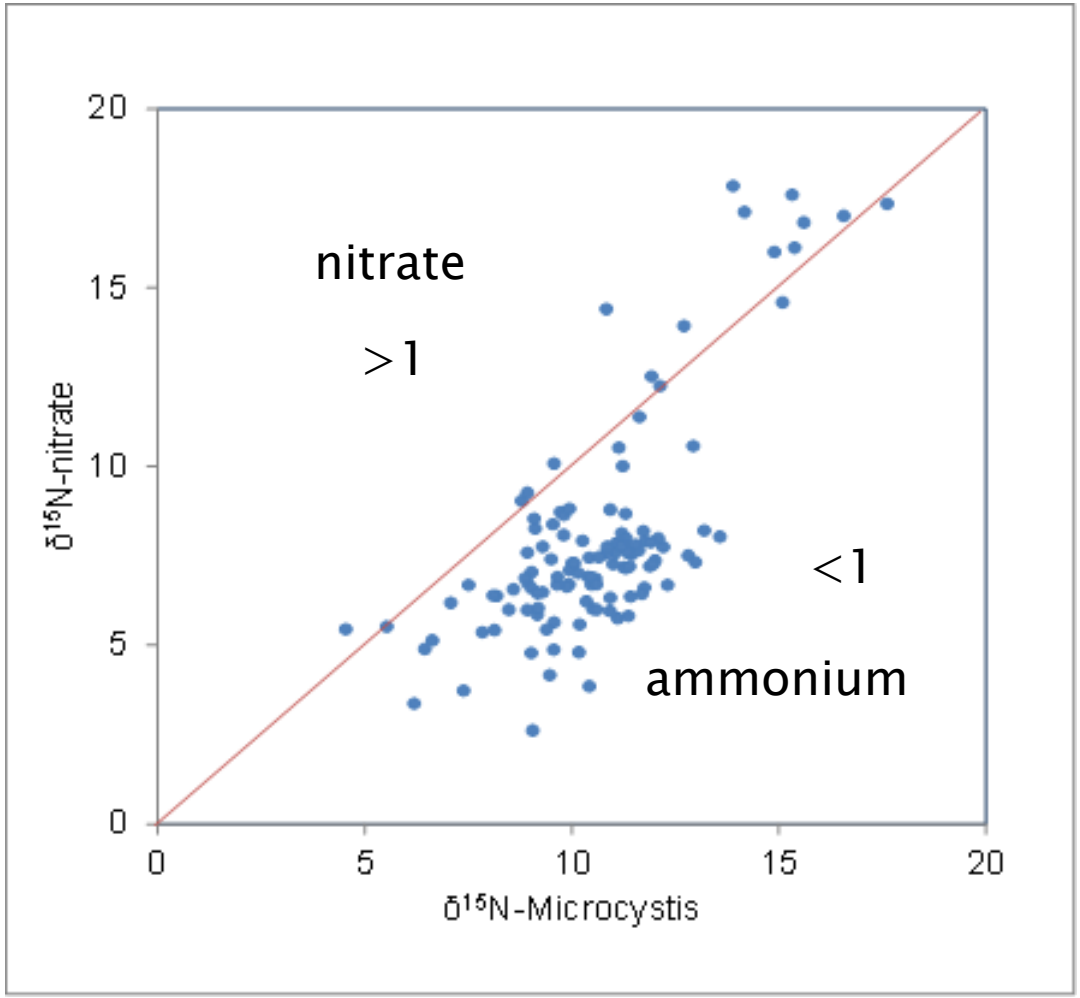




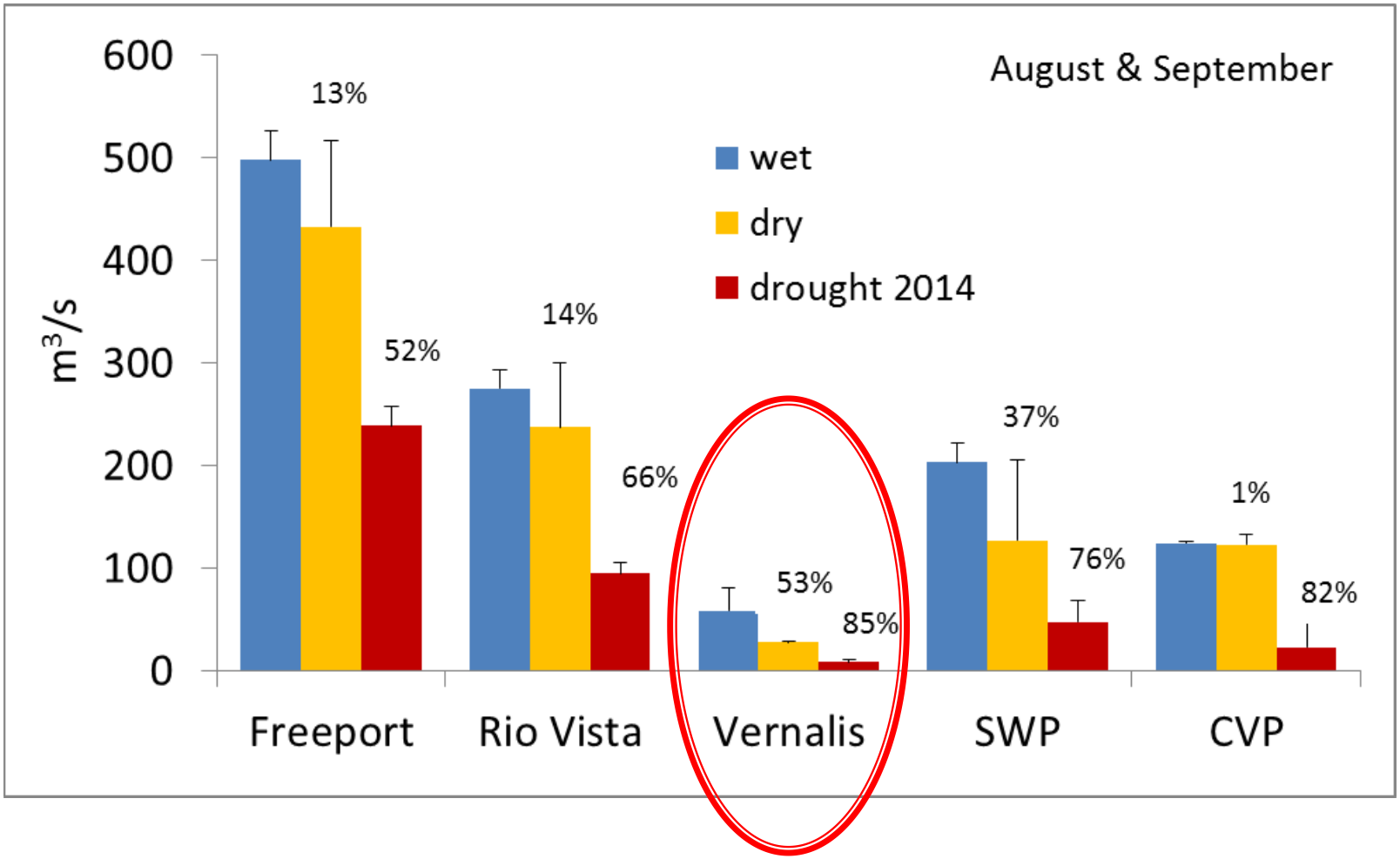


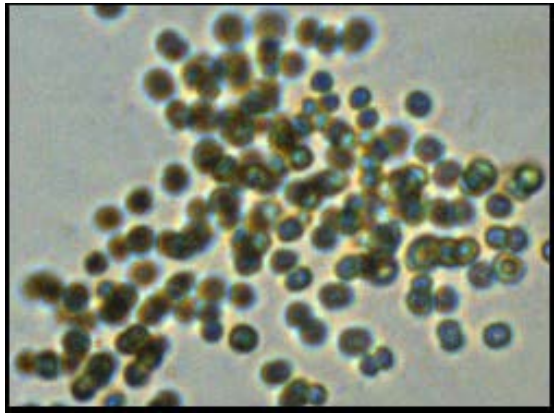


Nitrogen source – ammonium

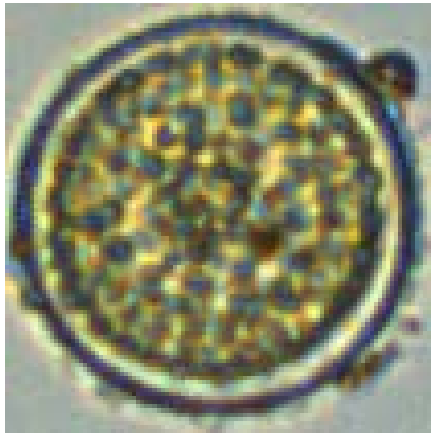


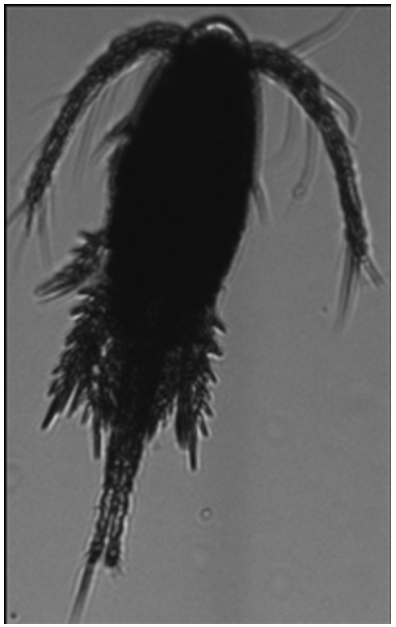
Streamflow


August & September
wet
dry
drought 2014
m3/s
600
500
400
300
200
100
0
13%
52%
14%
66%
53%
85%
37%
76%
1%
82%
Freeport
Rio Vista
Vernalis
SWP
CVP

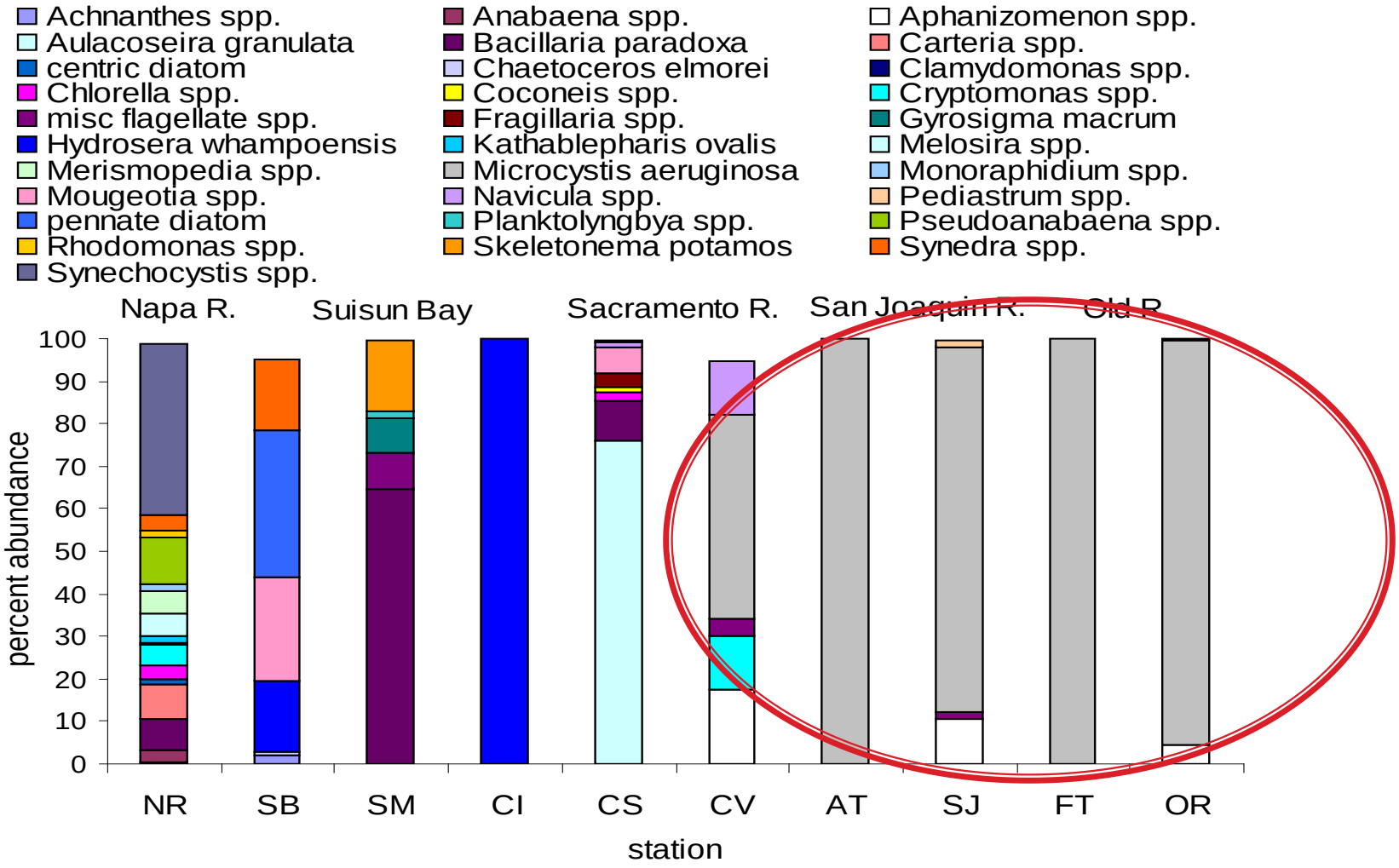


Biological Impacts



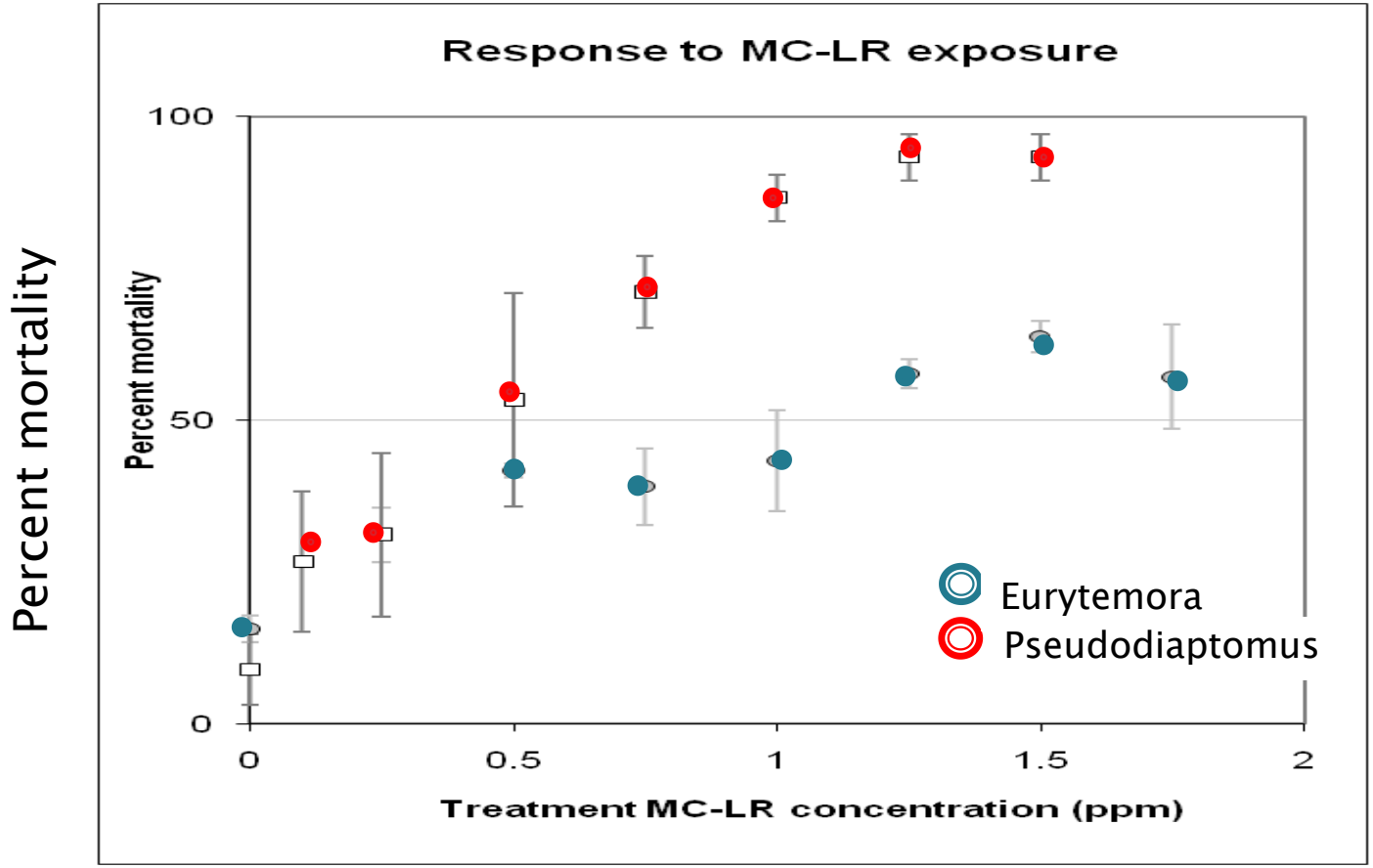


Reduces phytoplankton diversity



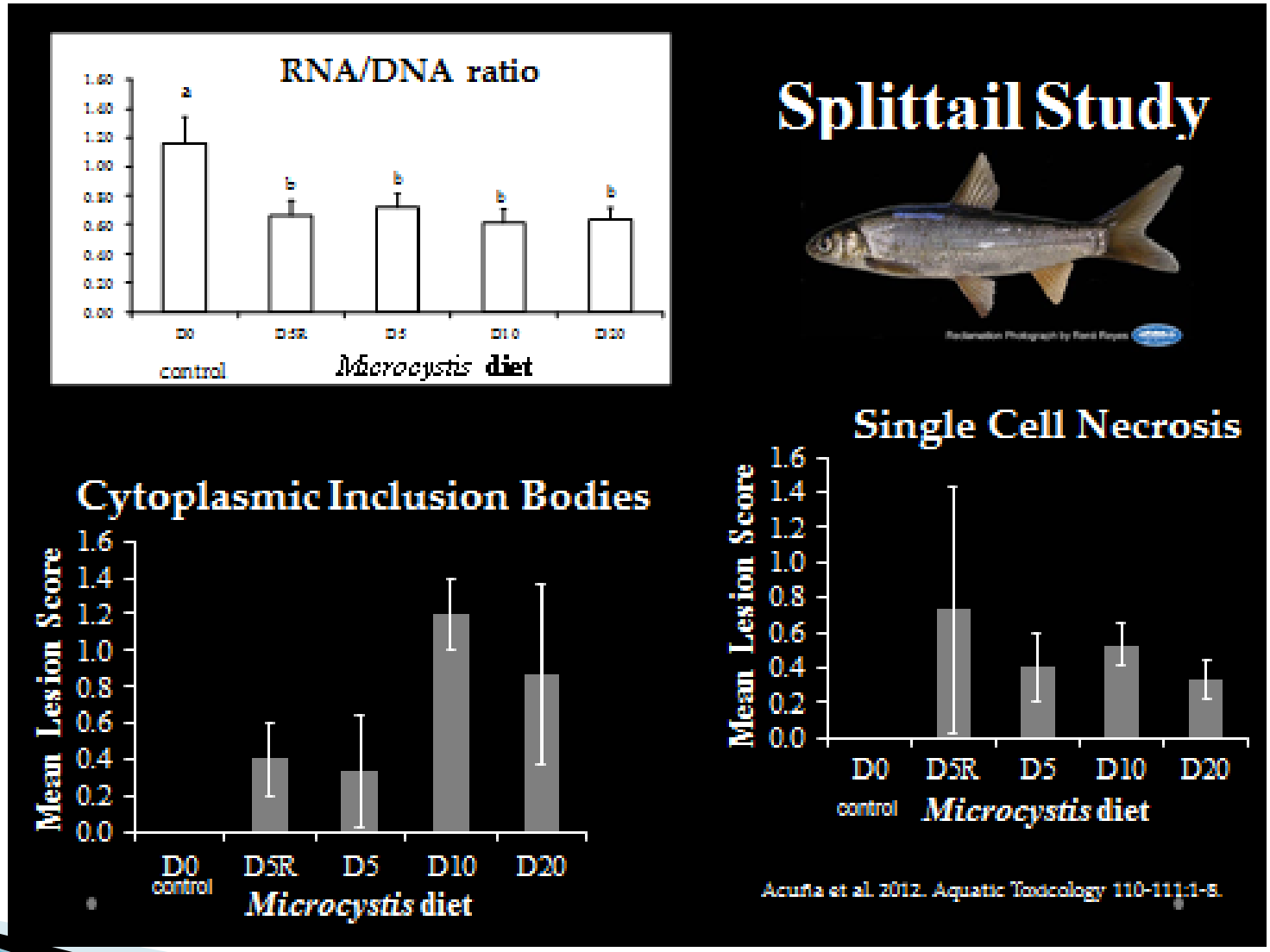
Lehman et al. 2010

Impairs zooplankton survival



Ger et al. 2010

Impairs Fish health



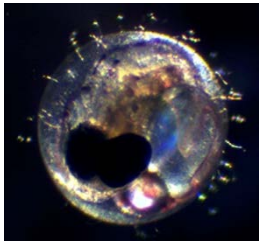
Acuna et al. 2012

Impairs fish embryo survival

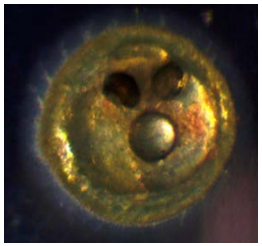
Percent Mortality

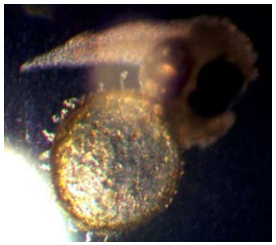
Station	August	September
AT	10	6
CV	3	3
BI	88	97
FT	84	88
JP	97	77
OR	94	97
MI	87	97
SJ	94	84
RR	97	78
Cont	0	3

control



treatment





Kurobe et al. in prep

Summary

- The biomass, toxin concentration, duration and cyanobacteria diversity of the *Microcystis* bloom during the 2014 drought was high and exceeded those in previous wet and dry years

- The peak of the 2014 bloom was associated with high phosphorus, specific conductance and dissolved organic carbon, as well as low ammonium concentration and streamflow

- Increased *Microcystis* blooms during drought conditions are a threat to the ecosystem structure and function because they adversely affect phytoplankton, zooplankton and fish production and community composition